Improved System Performance and Reduced Cost of a Fuel Reformer, LNT, and SCR Aftertreatment System Meeting Emissions Useful Life Requirement

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Agenda

• Introduction to Eaton Aftertreatment
• System cost reduction
• Durability demonstration of cost reduced system
• Fuel doser and system packaging
• Summary
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How it Works:

• Engine NOx is reduced by the Lean NOx Trap (LNT) and Selective Catalytic Reduction (SCR) catalysts.

• The LNT stores NOx and undergoes controlled periodic regeneration, releasing the NOx as nitrogen and NH₃.

• The SCR collects the released NH₃ and uses it to continuously treat the remaining NOx.

• A Diesel Particulate Filter (DPF) traps Particulate Matter (PM) and undergoes periodic regeneration.
Introduction

Typical Performance

• Proven Vehicle Performance
  • Tens of thousands of miles of EAS operation on MD and HD vehicles
  • Fuel consumption as low as 1.3%
  • Consistent NOx reduction performance meeting EPA 2010 standards
  • No vehicle drivability issues
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PGM reduction in the Reformer, LNT and DPF
PGM cost of the 2010 system is 36% lower than previous publication
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Durability
Aftertreatment Durability Aging

System Configuration
• Fuel doser, Fuel reformer, LNT, DPF, SCR

Sulfur Loading Assumptions
• Total Sulfur in exhaust: 12 ppm on a fuel basis
  • 7 ppm from diesel fuel & 5 ppm from oil

Triggered DeSOx Event: 0.5 g/L Sulfur on LNT
• LNT Sizing: 1.5 times engine displacement

Off-Highway Analysis
• 500 DeSOx events required - 8000 hour useful emissions life
  • One DeSOx event every 16 hours

On-Highway Analysis - Medium Duty Vehicles
• 225 DeSOx events required - 185,000 miles useful emissions life
  • One DeSOx event every 822 miles

On-Highway Analysis - Heavy Duty Vehicles
• 500 DeSOx events required - 435,000 miles useful emissions life
  • One DeSOx event every 870 miles
System Control - Desulfation
Reformer and LNT Temperature Control

ECU accurately controls reformer/LNT temperatures
Durability – 500 Desulfation Events
Previous End of Life Aging

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**Constant Control Settings**
- Sulfur Loading
- 50% Load
- 75% Load
- 100% Load
- SCR Cont.

**Final Performance (Optimized)**
- 1800-50: 93.5%
- 1800-75: 87.2%
- 1800-100: 78.7%

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Stable SCR Contribution

Reference: SAE 2009-01-2835
Durability – Comparison with Cost Reduced System

NO\textsubscript{X} Reduction Efficiency

Performance of cost reduced system is stable and meets end of life EPA 2010 emission standards

Reference: SAE 2009-01-2835

Added EATON-2010 Data
Cost Reduced System – Emission Results
Performance Under Various Modes

System out NOx meets EPA 2010 emissions standards

NTE limit
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Fuel Doser
Improved Spray Quality

- Early injectors showed a small cone angle with large drop diameters
- Improved injector shows larger cone angles having smaller drop sizes
- Smaller droplets yields better mixing in a smaller volume

Early injector (poor atomization with larger droplets)

Optimized injector (improved atomization & smaller droplets)
Improved mixing for compact packaging

REF – Reformer
LNT – Lean NOx Trap
DPF – Diesel Particulate Filter
SCR – Selective Catalytic Reduction

2010 MinNOx Conference
System Packaging
Application Examples

Off-Road Construction Vehicle

MD On-Highway Truck

REF – Reformer
LNT – Lean NOx Trap
DPF – Diesel Particulate Filter
SCR – Selective Catalytic Reduction
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- Demonstrated durable system performance that meets EPA 2010 on-highway emission standards

- System PGM cost 36% lower than previously published durability results

- Flexible and compact packaging options to meet OEM needs
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